ARCHIVE, ACCESS, AND SUPPLY OF SCIENTIFICALLY DERIVED DATA: A DATA MODEL FOR MULTI-PARAMETERIZED QUERYING WHERE SPECTRAL DATA BASE MEETS GIS-BASED MAPPING ARCHIVE. A. Naß[1], M. D'Amore[1], and J. Helbert [1]DLR, Institute for Planetary Research (Andrea.Nass@dlr.de, Mario.DAmore@dlr.de).

Introduction: Since the late 1950s a huge number of unmanned planetary missions were undertaken to explore our solar system. Since the 1990s, Europe has become highly active in planetary exploration with spacecraft contributions (e.g., Mars Express, Venus Express, Huygens probe, ExoMars, Rosetta), and the employment of dedicated mapping instruments. The data resulting from this robotic exploration and remote sensing varies in data type, resolution, and target. After different steps of pre-processing and correction, the released data are available for the community on different portals and archiving systems, e.g. *Planetary Data System* (PDS) or *Planetary Science Archive* (PSA).

One major usage for these data is *mapping*, i.e. the extraction and filtering of information by combining and visualizing different kind of base data. *Mapping* itself is conducted either for mission planning (e.g., identification of landing sites) or fundamental research (e.g., reconstruction of surface by multidimensional comparison of different base data (image data, spectral-/hyperspectral sensor data, radar images, and/or derived products like digital terrain model), identification of timing). The mapping results for mission planning are directly linked to and managed within particular mission teams. The valuable data and information derived from fundamental research - also describable as maps, diagrams, or analysis results - are mainly project-based and exclusively available in scientific papers. However, finding and accessing these valuable data to be used for further investigation is often not easy or downright impossible.

Therefore, one important question is how the derived mapping data described above can be archived comparably to the mission data, i.e. reusable, well-documented, and sustainable. A data archive is necessary, to enable further cross-links between different user groups and allows the reusability of already existing information and knowledge.

Thus, we discuss within this contribution:

Q1 How derived planetary scientific data like vector-based mapping, diagrams, and results of analysis can be archived, thus they could finally be used as additional base data for further investigations?

Q2 How different mission data (base data and derived products listed above) could be merged, to generate combined querying for the most efficient data and information handling?

Current Framework: Along with recent and upcoming missions also to Mercury (BepiColombo), the Outer Solar System moons (JUICE), and asteroids (NASA`s Dawn mission), systematic mapping of surfaces has received new impulses.

Since the late 1990s the scientific mapping community has started to use Geographic Information Systems (GIS) for planetary mapping. GIS frameworks are usually based on databases, which represent an ideal tool for generating, but also for archiving and storing spatial data - vector- as well as raster-based data.

To handle the two questions mentioned above, we build upon two developments, which are already established within the Institute of Planetary Science, DLR.

Part I: The Planetary Spectroscopy Laboratory (PSL) group at DLR joins the Participating Scientists for MESSENGER program for the Mercury Atmospheric and Surface Composition Spectrometer (MASCS) instrument, allowing access to the team data before the official release to PDS. MASCS have mapped Mercury surface in the 400–1145 nm wavelength range during orbital observations by the MESSENGER spacecraft. To overcome the dataset bulk size and fully exploit the information present in it, we developed a PostgreSQL/PostGIS distributed database. The DB contains the whole MASCS spectral dataset, around 4 Million single measurements as vector data, and user defined polygons. To explore possible relations between composition and spectral behavior, we have imported other dataset, like the elemental abundance maps derived from MESSENGER's X-Ray Spectrometer (XRS).

Part II: In the last years the Department of Planetary Geology, DLR established a GIS-based mapping archive (concept, and evaluation version) storing all different kind of derived vector-based mapping projects, which are conducting within different investigations. To enable and ensure a sustainable use of the derived data, two topics are treated: 1. Comparability and interoperability has been made possible by standard recommendations for visual, textual, and structural description of mapping data (e.g. [1], [2]). 2. Interoperability between users, information- and graphic systems is possible by templates for digital mapping and data bases (e.g. [3], [4]).

Therefore, this data base driven archive has to cover the requirement, (1) applicable for all known planetary bodies, (2) usable in the proprietary environment ArcGIS™ (ESRI), but also usable and accessible within independent and open GIS systems, like e.g. QGIS, (3) developed, or at least transferable, into a PostgreSQL/PostGIS driven data base structure, and last but not least, (4) the archived data should be available and replicable for future investigations.

One first implementation was conducted for the systematic mapping of Ceres (Dawn mission), is useable also outside the DLR, and was presented, e.g. [5].

Application: The current spatial intersection within *Part I* is a computation-heavy operation that is executed in the backend in period of low activity, typically at night. The current resulting features–measurements polygons intersection is stored in caching tables, allowing a quasi-live retrieve in GIS system from user perspective. The overhead in complexity is justified by the circumstance that the spatial query is executed only once, whereas the retrieving of the data could happen multiple times. Overall, despite the additional complexity and overhead to join different table, this approach optimizes the access time for spatial intersection. We are currently working on merging the GIS-based map archive to the PSL database to enable the data query for spectral data by the polygons, done within geologic/geomorphologic mapping projects.

Conclusion: The idea behind this contribution is to ingest the product of surface mapping done by experts (e.g., geomorphological or geological mapping), and intersect those features with the actual data, to extract spectral information in well know geological regions (Figure 1). The ingestion architecture expects a minimum set of feature to be defined by the user.

Three examples of this approach are: 1. the comparison spectral behavior with radial distance in more than 100 craters on the surface of Mercury (Figure 1, left) [6], 2. the identification of Olivine outcrops on the surface of Vesta via DAWN data analysis [7], 3. A general automated multi instrument mapping framework [8, 9].

The current approach shows that databases described as *Part I* and *Part II* are (1) theoretically transferable to any planetary body, e.g. from Moon, Mars, (2) through the spatial context all these data hold by nature, the two parts are combinable, this (3) enables an overarching and comparative research and analysis basis by multi-parameterized querying, and would (4) benefits the knowledge management and data/product usability for future missions and data.

Summary: An archive of already gained information supports the scientific community significantly by a constant rise of knowledge and understanding based on recent discussions within Information Science and Management, and Data Warehousing. An archiving structure and additional reference level of derived and already published data could easily be transferred to other scientific fields, and be linked to other planetary mission data, e.g. laser altimeter data [10].

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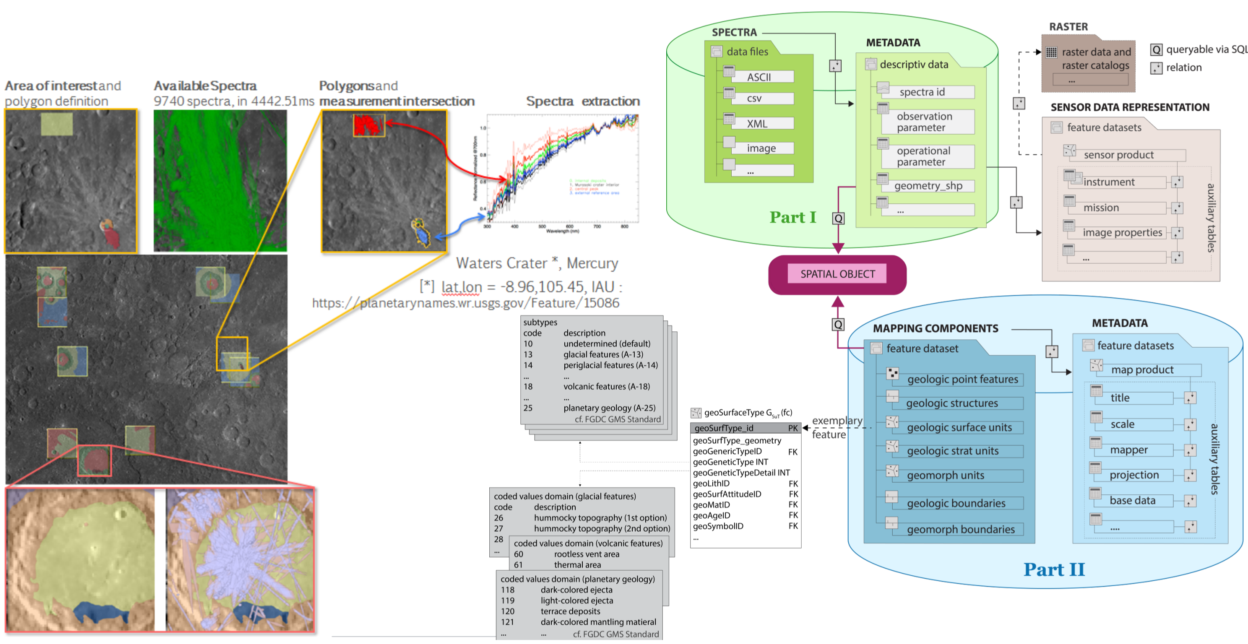

Figure 1 *left*: comparison spectral behavior with radial distance in more than 100 craters on the surface of Mercury [6], *right*: schematic and simplified model of *Part I* – spectral, and *Part II* – mapping database, inclusive metadata entries.